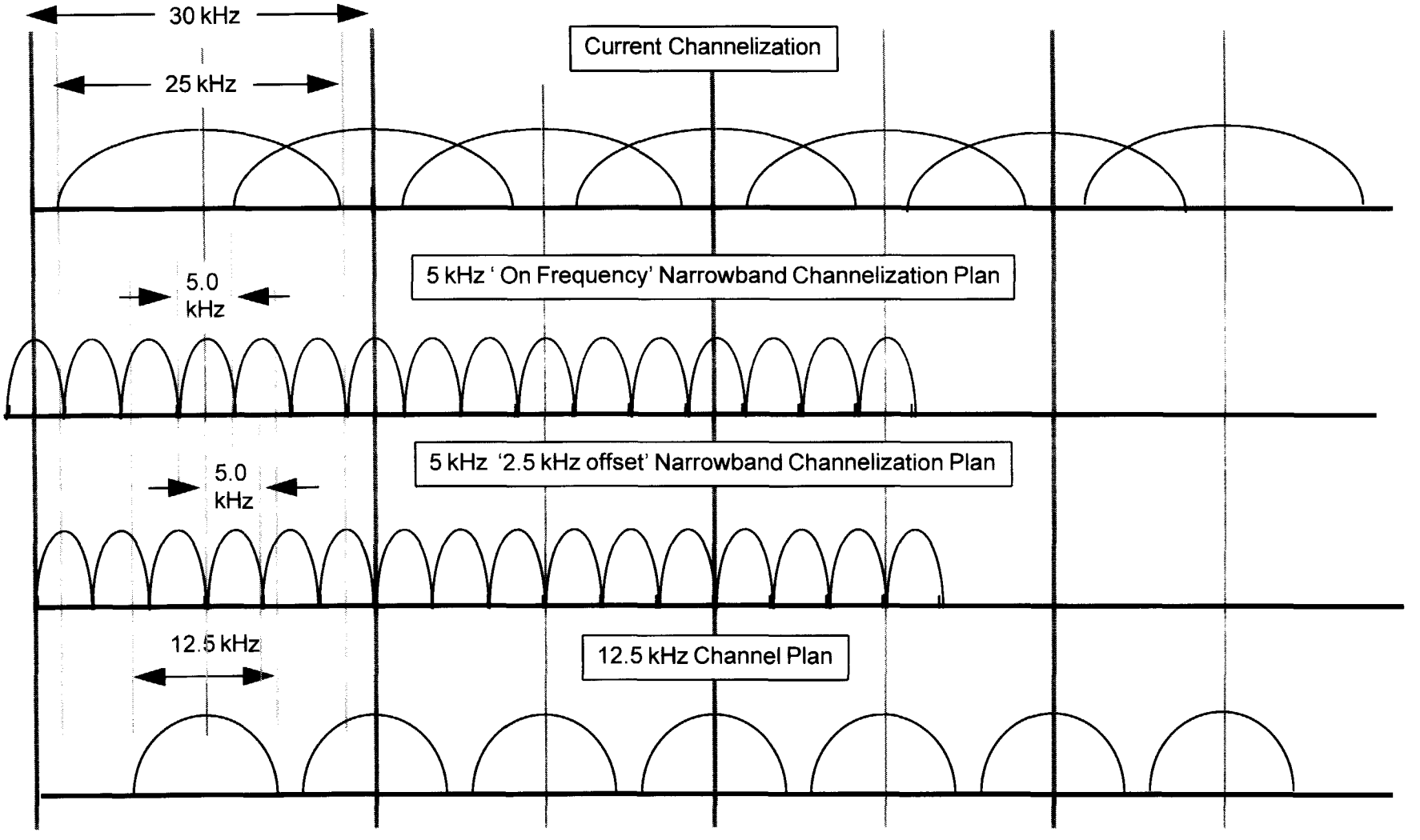
FIGURE 1

5 kHz VHF Migration



5 kHz Channel Migration Options

VHF

FIGURE 2

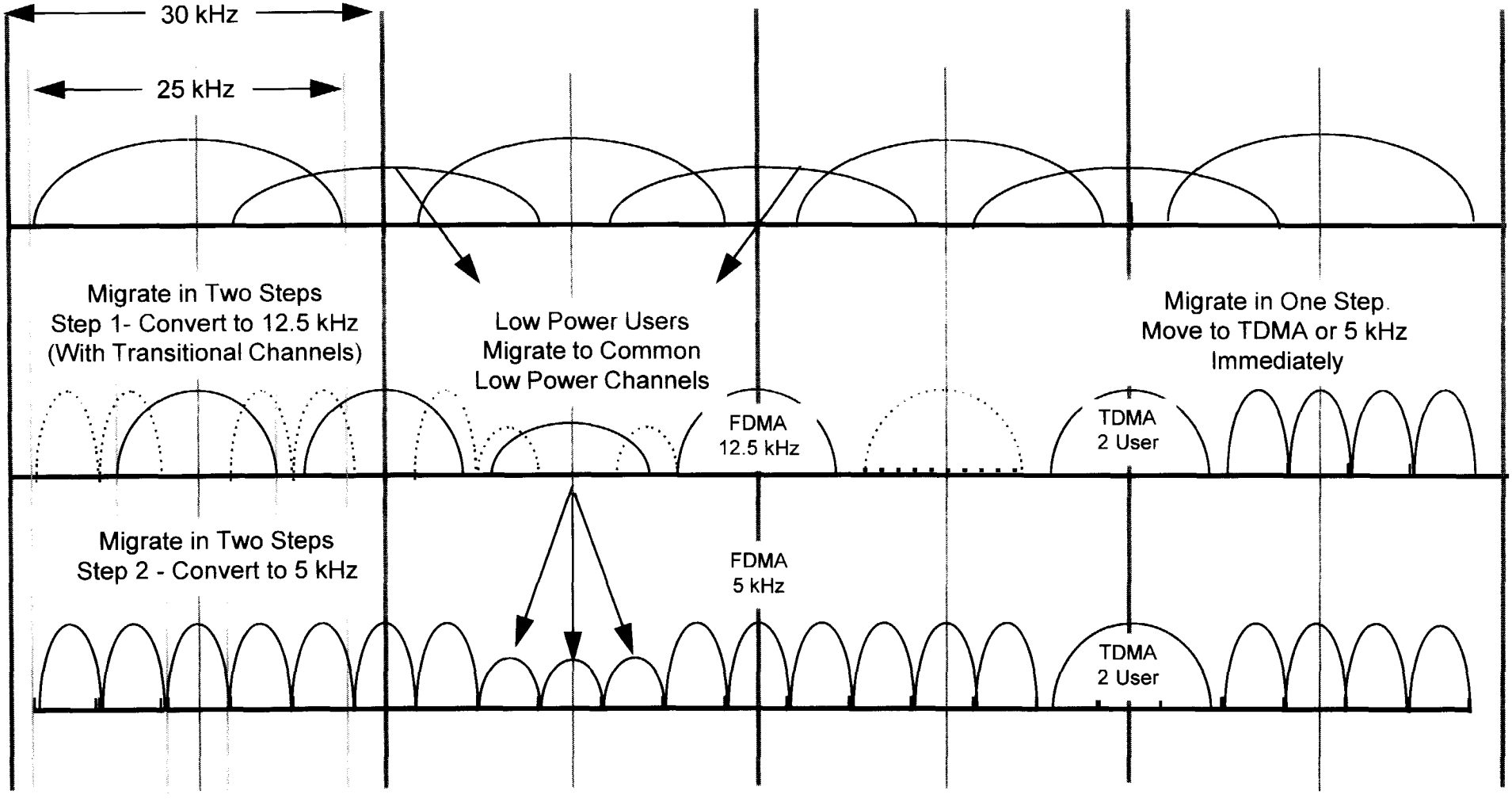
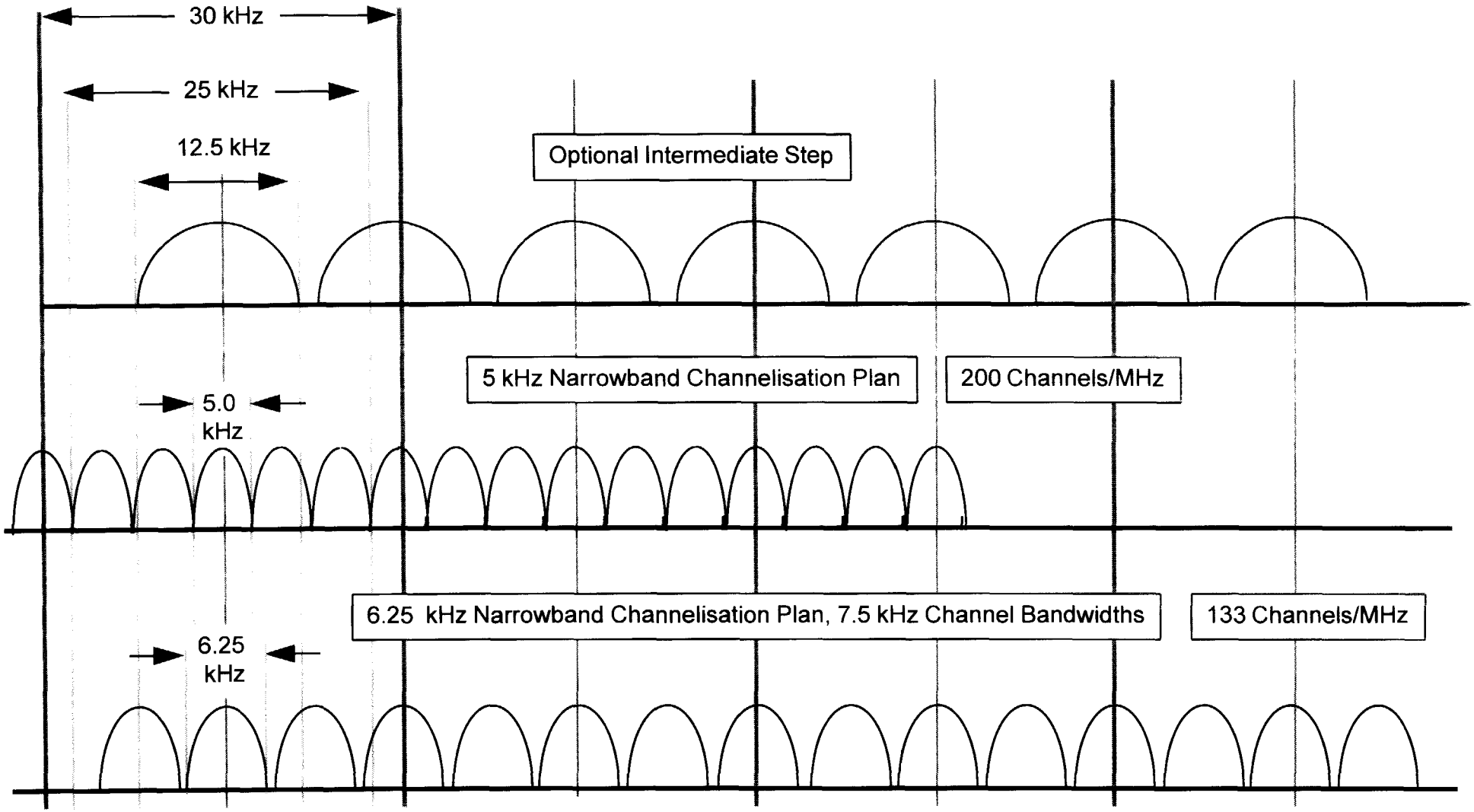


FIGURE 3

5 kHz VHF Migration

5 kHz and 6.25 kHz Final Plan Comparison



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Figures 4 through 8 depict the flexibility of a 5 kHz band plan in ensuring an orderly migration to advanced technologies in the UHF bands. Figure 4 illustrates a two stage transition on-channel to a 5 kHz plan. Existing high-power licensees could remain on-channel through a two-stage transition to narrowband technology. The existing low power offset licensees ultimately would be accommodated on-channel by this plan by low power channels offset 2.5 kHz from the 5 kHz channel centers.[22]

Figures 5 though 7 show the flexibility of various 5 kHz band plans in accommodating multiple wideband equivalent technologies, and in providing maximum interference protection to existing users. Figure 8 compares a 5 kHz plan with the 6.25 kHz plan adopted by the R&O and demonstrates the increased channel capacity offered by the 5 kHz plan.

[22]The R&O (at para. 66) channel plan indeed provides for implementation of low power offsets in the UHF bands.

5 kHz UHF Migration

(Channel Centering)

FIGURE 4

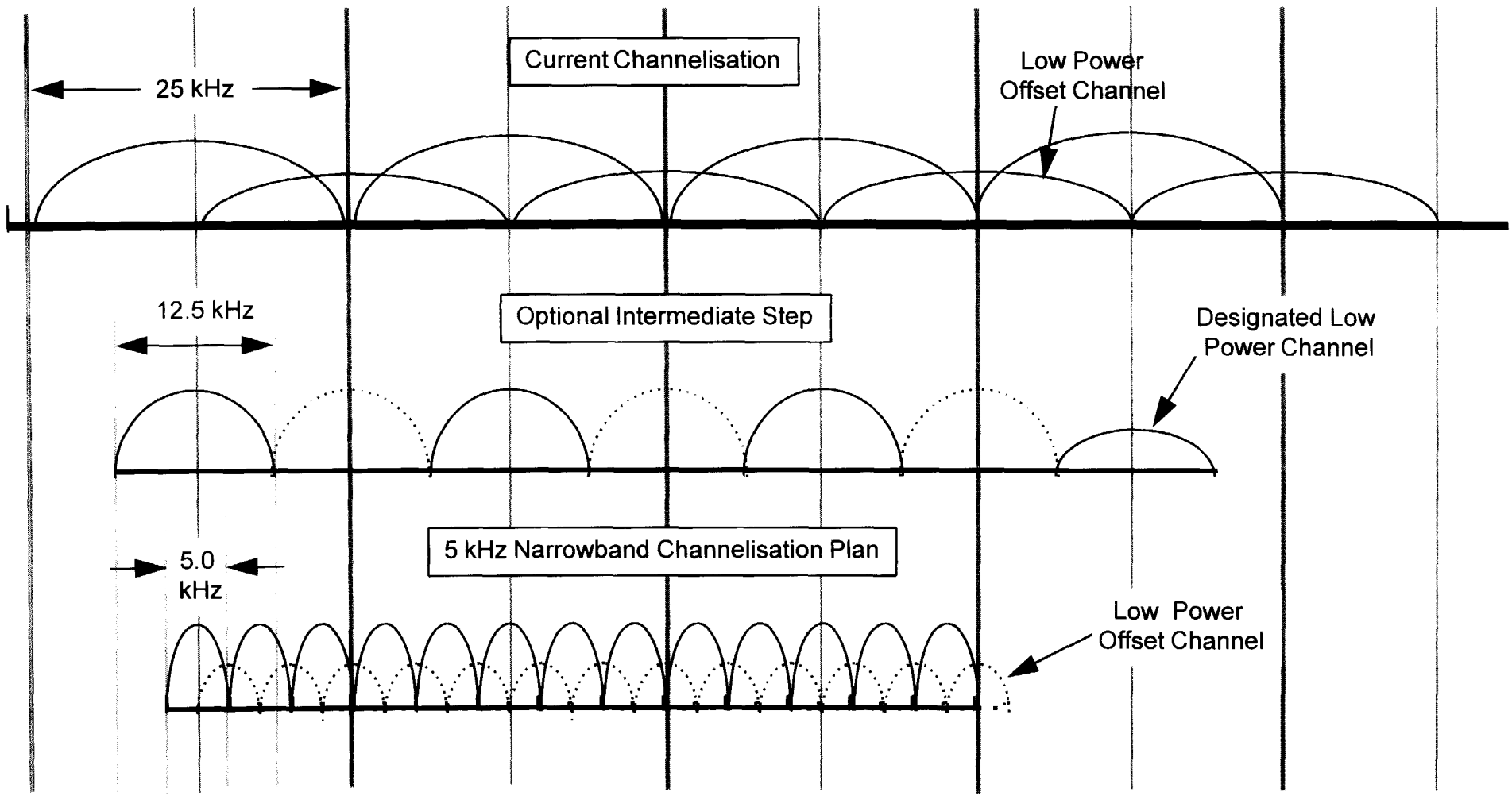

FIGURE 5

5 kHz Channel Migration Options

UHF-1(Channel Centering)

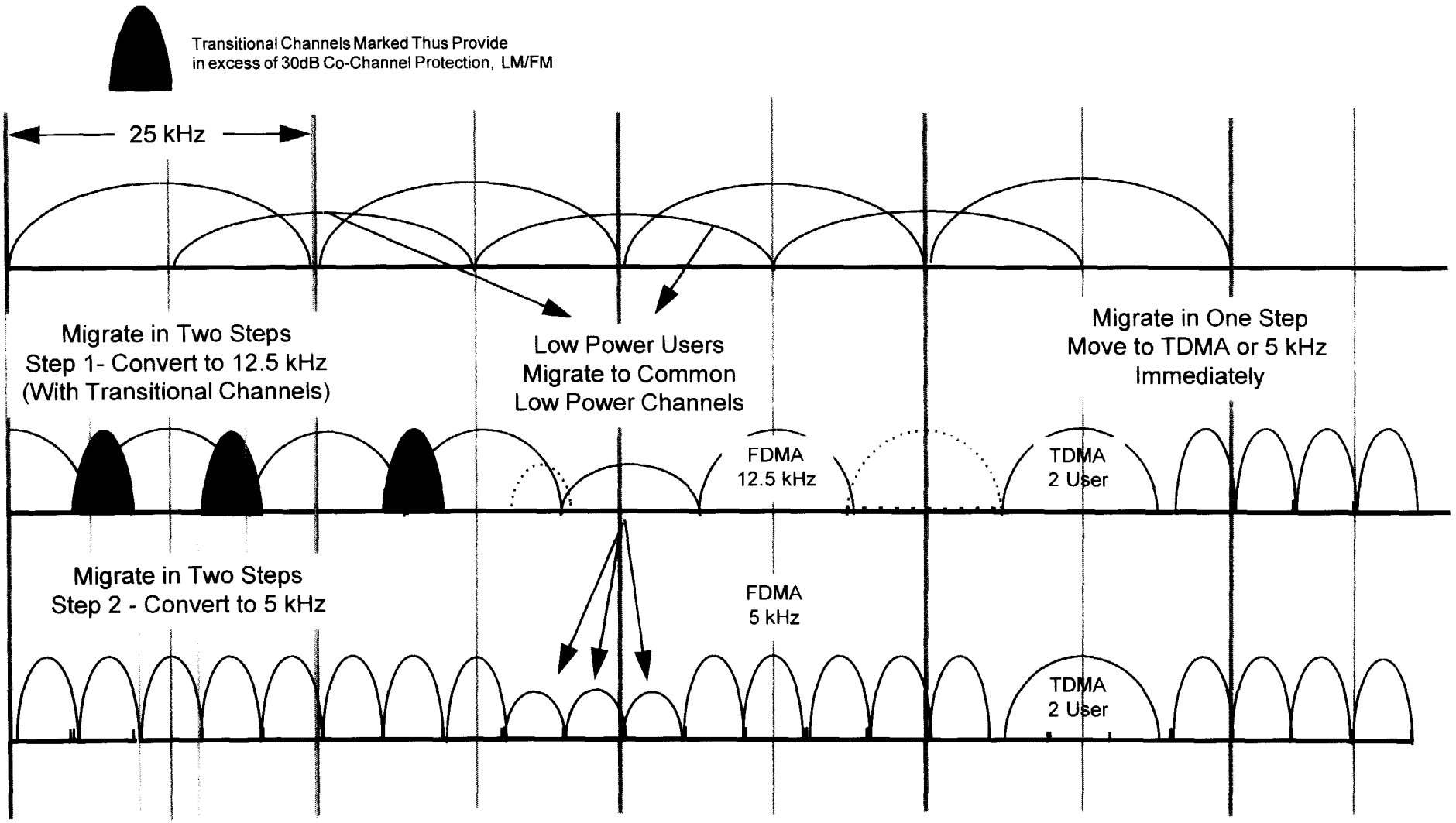

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FIGURE 6

5 kHz Channel Migration Options

UHF-2 (Start 3.75 kHz High on Band Edge)

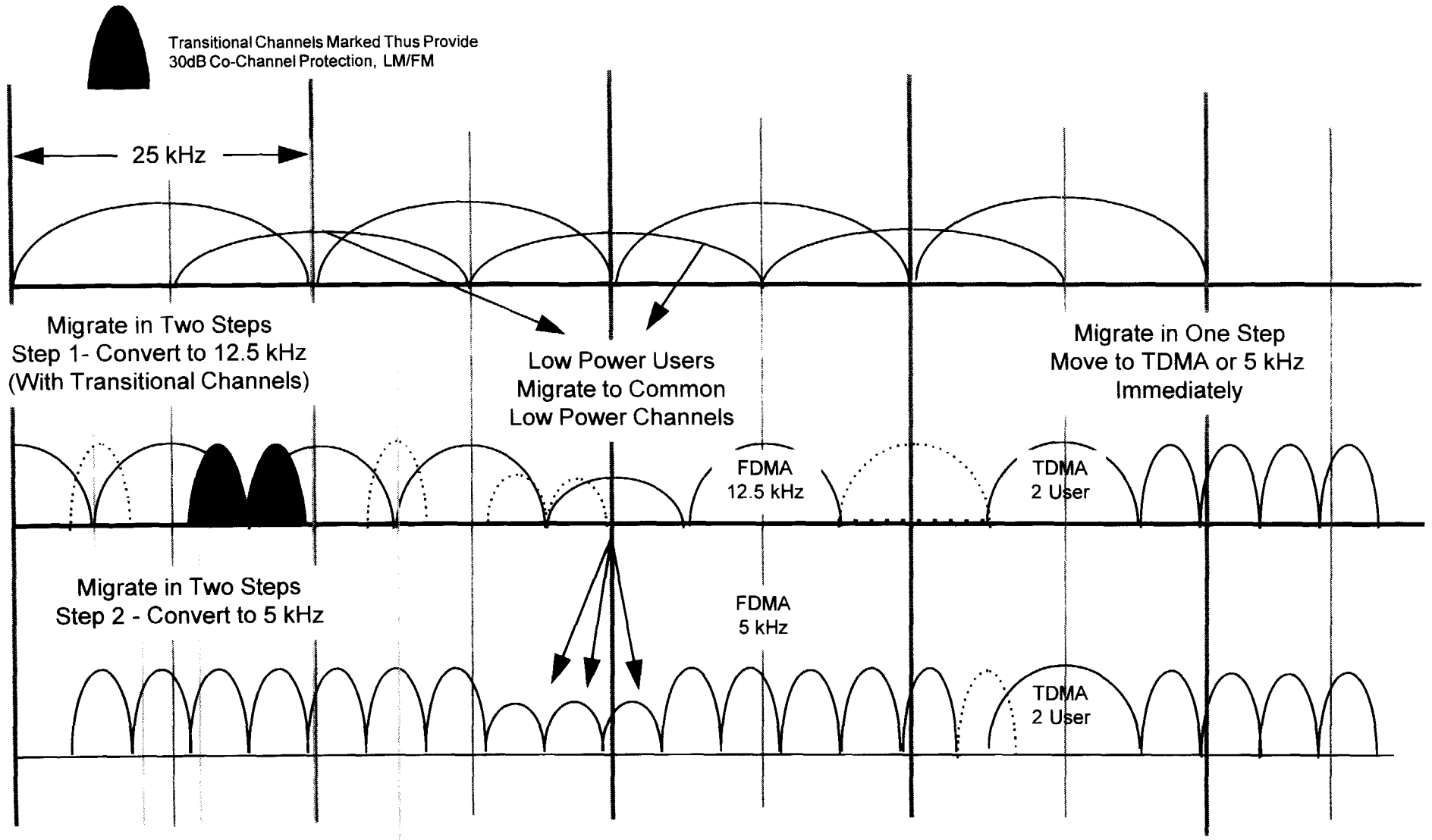

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FIGURE 7

5 kHz Channel Migration Options

UHF- 3 (Start 1.75 kHz High on Band Edge)

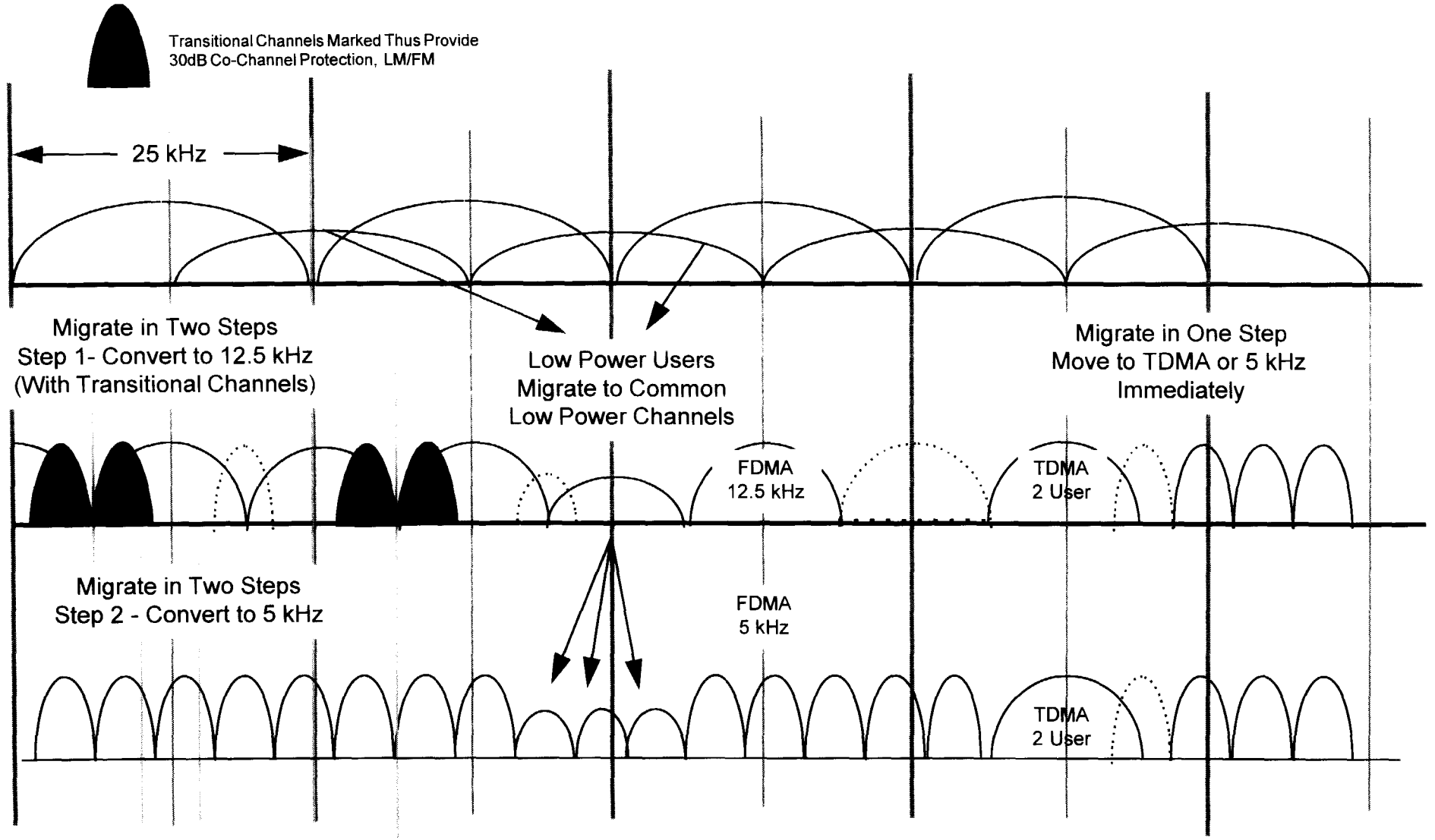

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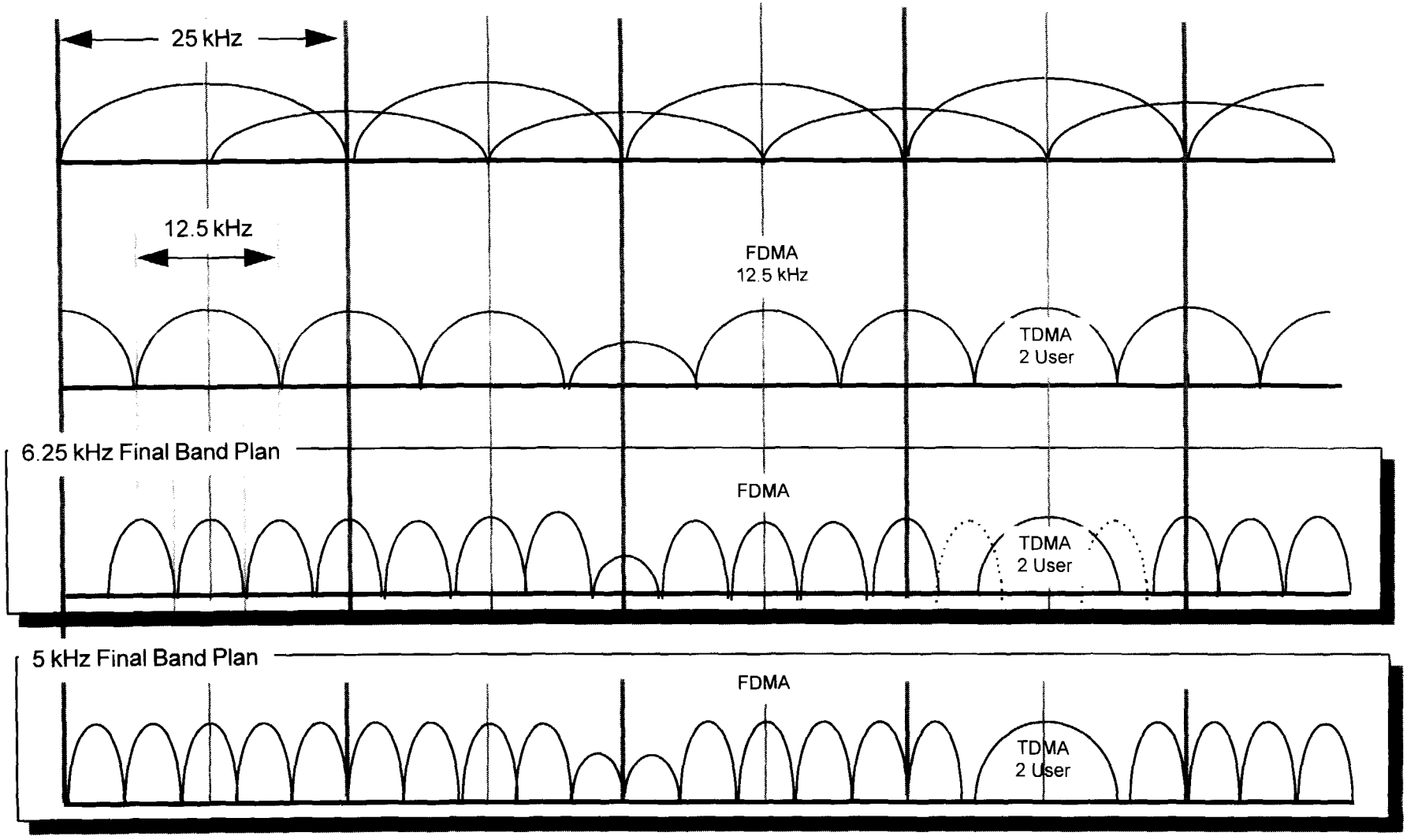
FIGURE 8

UHF Channel Migration Options

6.25 kHz (Channel Centering) Versus 5 kHz (Channel Centering)



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Securicor appreciates the Commission's desire to minimize the disruption to existing licensees by ensuring that they may remain on-channel through a two stage transition to narrowband technology. From a practical standpoint, however, employing an offset channel plan, such as those presented in Figures 1, 6 and 7 above may better serve existing users by minimizing interference to and from new users. Moreover, the migration to narrowband technologies under a 5 kHz plan without the need for existing licensees to retune mobiles may be accomplished through backward compatibility. Securicor's LM equipment is currently backward compatible to 12.5 kHz FM systems and we anticipate introducing LM equipment backward compatible to 25 kHz FM systems in the near future.

Accordingly, the 5 kHz channel plans presented above are as capable of accommodating both existing users and wideband equivalent technologies as the 7.5 kHz/6.25 kHz plans selected by the R&O.[23] The 5 kHz plans, however, provide significantly

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[23]The 5 kHz band plans in addition would accommodate 6.25 kHz NB equipment in the event that equipment is developed for deployment in the refarmed bands. Aggregation of two 5 kHz channels of course would readily accommodate 6.25 kHz equipment. The licensing of 6.25 kHz technology on a single 5 kHz channel would require only good system planning. For equipment capable of operating in a bandwidth of 6.25 kHz or less, the Commission specified in new §90.210 that signals greater than 3 kHz from the center frequency must be attenuated by at least 30 + 16.67 (f_d - 3kHz) dB. In the range from 0 kHz to 3 kHz, no attenuation is required. A 6 kHz occupied bandwidth signal channeled on 5 kHz centers has 500 Hz of bandwidth lying inside the adjacent channel at 0 dB attenuation. At the edge of the 6 kHz signal, power is attenuated by 30 dB, and it decreases at the rate of -16.67 dB/kHz thereafter to -65 dB from the channel center value. The power in the adjacent channel is attenuated 63.3 dB 5 kHz from

enhanced capacity over the 7.5 kHz/6.25 kHz plans and thus would better accomplish the goals established for this Docket.

V. THE R&O's BAND PLANS IMPOSE SUBSTANTIAL COSTS

In the R&O (at para. 2), the FCC notes that its primary goal in this proceeding is to "develop an overall strategy for using the spectrum in the PLMR allocations more efficiently to meet future communications requirements." Fundamental to meeting this challenge is a consideration of the economic impact of the FCC's decision on all impacted segments of the PLMR industry in particular and the U.S. economy in general.

Spectrum policymaking in the U.S. has evolved significantly as a result of the implementation of spectrum auctions. This is manifest in virtually every decision impacting the Commission's spectrum management since passage of the Omnibus

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the center of its assigned channel and reaches its maximum attenuation at f_d = 5.1 kHz, 100 Hz past the center of the adjacent channel. In a 6.25 kHz spaced system using the Commission's prescribed emission mask, the power at the adjacent channel edge (3.125 kHz) is 32.1 dB less than that at the center frequency, 34.2 dB at the edge of the adjacent channel modulation envelope (3.25 kHz) and decreases to -65 dB at 5.1 kHz. The attenuation will then remain at that level throughout the adjacent channel.

To obtain the same attenuation level of 34.2 dB at the edge of the adjacent 5 kHz channel, either frequency selective components or distance can be used to obtain isolation. Antennas for channels immediately adjacent in frequency assignment, for example, at 152.300 MHz and 152.305 MHz, must be spaced 3 meters vertically or 10 meters horizontally to achieve the same isolation as would be achieved in a 6.25 kHz channeling plan. Neither distance would measurably affect signal contour.

Budget Reconciliation Act of 1993.[24] The Further Notice of Proposed Rule Making in this Docket indeed centers its discussion, appropriately, upon the need to drive users to economic spectrum decisions.

Consistent with the evolution in spectrum policymaking, as noted above, Securicor commissioned Hatfield Associates, Inc. to undertake an Economic Impact Analysis of the R&O. The Hatfield Study "The Economic Impact of Refarming," is appended to this Petition. The Study examined, at Securicor's request, valuations of the channel capacity in the UHF and VHF Bands that would have been available with a 5 kHz band plan. The Hatfield Study did not quantify externalities, including the economic contributions that could be made by particular 5 kHz technologies, including LM, or the indirect economic impact resulting from the direct economic losses.

The Hatfield Study concluded that the lost channel capacity (reflecting 5.88 MHz total between the VHF and 450-470 Mhz bands and 2.16 MHz in the 470-512 MHz band) potentially represented up to $7.6 billion in foregone Federal revenues using the valuation methodology suggested by the FCC in the FNPRM at

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[24] See, e.g., Amendment of Parts 2 and 90 of the Commission's Rules to Provide for the Use of 200 Channels Outside the Designated Filing Areas in the 896-901 MHz and the 935-940 MHz Allocated to the Specialized Mobile Radio Pool, PR Docket 89-553, FCC 95-159 (April 17, 1995); Allocation of Spectrum Below 5 GHz Transferred From Federal Government Use, ET Docket No. 94-32, FCC 95-319 (August 2, 1995); Statement of Chairman Reed E. Hundt before the Subcommittee on Telecommunications and Finance of the House Committee on Commerce, 1995 FCC LEXIS 4022 (June 19, 1995).

para. 138. Employing the SMR industry as a base model, Hatfield further estimates that the lost PLMR capacity also reflects a loss of almost 8,800 full time service jobs for the U.S. economy, and 26,500 year-long manufacturing jobs. Hatfield further estimates that the foregone capacity could have provided service to 3.6 million users. Clearly, these costs are substantial.

Beyond even these numbers, however, lie even further costs in the form of lost wages, lower consumer spending, and lessened efficiency due to PLMR operations. In addition, the competitive impact of a lessened market must also be addressed.

The R&O does not, however, reach the issue of the economic impact of the foregone channel capacity. In Securicor's view, however, any trade-offs made in the R&O must be viewed against the economic costs of those trade-offs. Securicor thus urges that the FCC revisit its VHF and UHF band plans in view of the estimated costs of those decisions.

VI. THE R&O IS BASED UPON A STALE RECORD

In the almost two years between the closing of the Comment cycle and the date the R&O was adopted by the Commission, several major developments have fundamentally affected the way spectrum is managed. As a result, Securicor believes that the record in this proceeding has not provided the Commission a sufficient basis to properly evaluate the economic costs of its decision. Accordingly, Securicor urges that the Commission undertake an extensive analysis of this issue on reconsideration.

Since this proceeding was initiated, Congress granted the Commission the authority to use competitive bidding to award licenses when mutually exclusive applications were received for initial licenses to provide subscriber-based services. Pursuant to that authority, since the close of the Comment cycle for this Docket, the FCC has conducted auctions for the IVDS service, nationwide and regional narrowband PCS licenses and broadband PCS licenses. As the Commission has noted elsewhere, "[e]stablishment of competitive bidding authority creates a new dynamic for the assignment of licenses."[25] But reaping these rewards has only served to highlight the need to implement regulations that support a policy geared toward maximizing spectrum efficiency and encouraging further speedy deployment of new services and technologies.

In addition, the rollout of the 220 MHz industry based upon 5 kHz channelization has occurred since release of the NPRM. Although that rollout is still underway, by year's end, many thousands of 5 kHz channels will be in commercial operation throughout the nation. Manufacturers, including Securicor, have invested millions of dollars to add factory capacity to accommodate this rollout, establish dealer networks, train customer support personnel and enter into other business relationships to support these efforts. Services and products in the 220 MHz band are expanding daily as a result of the 5 kHz

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[25] Review of Pioneer's Preference Rules, ET Docket No. 93-266, 8 FCC Rcd 7692-93 (1993).

spacing plan that permits voice and data communications and allows for an increased number of users. The PLMR industry should not risk the costs of orphaning the 5 kHz technology and the 220 MHz industry that may result from the FCC's decision in this Docket.[26] Neither the record in this Docket nor the R&O adequately addresses the competitive impact of the refarming decision on the nascent 220 MHz industry.[27]

VII. TECHNICAL RULES

A. In-Channel Restrictions

In its R&O at paras. 79-80, the FCC adopts an authorized channel bandwidth of 6 kHz for a 6.25 kHz channel and 11.25 kHz for a 12.5 kHz channel bandwidth. The R&O (para. 93) also adopts frequency stability requirements. Securicor urges that the FCC reconsider these rules to better accommodate advanced technologies.

Securicor respectfully suggests that for advanced technologies like LM these requirements are unnecessary and should be eliminated altogether. Advanced technologies are able,

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[26]This risk was identified in an Ex Parte submission made by the FCC in this Docket in July, 1994.

[27] See, e.g., Eligibility for the Specialized Mobile Radio Services in the 800 MHz Land Mobile Band, PR Docket No. 86-3, 7 FCC Rcd 4398 (1992) (numerous changes in the SMR industry since Notice was issued warrant termination of the docket); Amendment of Part 69, RM-6113, FCC 90-5, released January 11, 1990 (two and a half years since rule making petition filed; Decreased Regulation of Certain Basic Telecommunications Services, 5 FCC Rcd 5412 (1990) (three years since issuance of proposed rule making); Amendment of Part 94, 5 FCC Rcd 487 (1990) (four and a half years since issuance of proposed rule making).

for example, to take advantage of digital filtering, thereby enabling more of the total channel bandwidth to be utilized without affecting adjacent channel interference. In a complicated RF environment with different technologies using varying bandwidths (e.g., TDMA), limitations on in-channel use, such as authorized channel bandwidths and frequency stability requirements that are based upon older, less spectrally-efficient technologies will dilute the benefits that may be gained as a result of the advancements in technology. Accordingly, those restrictions may impair the competitiveness of the newer technologies which, in turn, may dampen the incentives for manufacturers to continue to invest in research and development activities.

In place of these in-channel restrictions, Securicor suggests that out-of-band emissions should be regulated entirely by adjacent channel interference criteria. This will enable advanced technologies to take the maximum advantage of the available spectrum for the benefit of the user while ensuring sufficient protection to adjacent operations.

B. Emissions Mask

With regard to the emissions mask, Dr. Gregory M. Stone's analyses and recommendations for the use of linear technologies for narrowband communications systems are meaningful and representative of the progress being made in narrowband technologies. Indeed, the highly linear technologies described are publicly available and are being applied by most of the

manufacturers of very narrow band technology, chief among them Uniden, SEA, E.F. Johnson and Securicor. Stone also suggests, in proposing "brick wall" filters, that ". . . the promulgation of flexible standards permitting full channel bandwidth occupancy under certain specific conditions is not only highly desirable, it is practicable and in our judgment essential to promote technology advancement."[28] The technical parameters adopted must promote the implementation of these bandwidth/spectrally efficient technologies. Securicor thus urges the Commission to reconsider its emissions mask and adopt Stone's proposal.

Securicor, in addition, requests that the FCC reconsider the adjacent channel emissions limitations provided in Section 90.210(d)(3) of the Rules. In particular, Securicor suggests that the use of the ratio of the average power in the wanted channel to the average power in the first, second and third adjacent channels would be a more accurate barometer of adjacent channel emissions. To establish a good adjacent channel environment, Securicor suggests that the FCC should require that these ratios should be 60 db or better.

C. Two-Frequency Operation In The VHF Band

The R&O does not address the issue of paired frequency operation in the VHF Band. Securicor believes, however, that the pairing of channels in the VHF Band will significantly enhance the capabilities of that Band and will enhance the value of that

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[28] Comments of Dr. Gregory M. Stone at 7 (emphasis in original).

Band generally for the PLMR community. If in the implementation of the two frequency channel plan, the interference to the one frequency incumbent system is considered, the band will grow into a two frequency channel system at a rate determined by the user community with as little disruption as practicable.

VIII. CONCLUSION

For these reasons and as substantiated in the attached Economic Impact Analysis, Securicor respectfully requests that the FCC reconsider the R&O and adopt the modifications to its Rules requested herein.

Respectfully submitted,

SECURICOR RADIOCOMS LIMITED and
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August 18, 1995

THE ECONOMIC IMPACT OF REFARMING

Prepared by

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August 18, 1995

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ECONOMIC IMPACT OF REFARMING

I. Introduction

In its Report and Order and Further Notice of Proposed Rule Making ("R&O/NPRM") in PR Docket No. 92-235 released on June 23, 1995, the Federal Communications Commission ("Commission") adopted new "narrowband" channel plans for certain private land mobile radio bands. In doing so, the Commission rejected a 5 kHz channelization plan advocated by Securicor Radiocoms Limited ("Securicor") and, instead, specified 7.5 kHz and 6.25 kHz channelization plans for the VHF and UHF private land mobile radio bands, respectively. In July, 1995, Securicor retained Hatfield Associates, Inc. to undertake a study of the economic-related consequences of choosing the band plan specified by the Commission in the R&O/NPRM versus the channelization plan advocated by Securicor. The purpose of this report is to convey the results of that study.

The balance of this report is divided into sections as follows: Section II contains the assumptions underlying the analysis, while Section III provides an estimate of the additional capacity that would be created by the adoption of the more spectrum-efficient channelization plan advocated by Securicor. Section IV provides estimates of the economic value of the additional capacity, while Section V provides estimates of (a) the value of incremental equipment sales that would be made possible by the additional capacity, (b) the additional manufacturing jobs in the wireless manufacturing industry through those equipment sales and (c) the value of the incremental spectrum in terms of the number of additional end users that could be served. Section VI provides an estimate of the contribution of private land mobile radio ("PLMR") services to the economy more broadly. Finally, Section VII contains the summary and conclusions of the study.

II. Assumptions

In carrying out this study, it was necessary to make certain technical and economic assumptions. The purpose of this section is to set forth those assumptions and the basis or rationale for them. Other assumptions are discussed at appropriate points in the sections which follow.

With the release of the R&O/NPRM, the Commission has embarked upon a regulatory program that will eventually lead to a 7.5 kHz channelization plan for the VHF band and a 6.25 kHz channelization plan for the UHF band. Because of various technological advances, including the Linear Modulation (LM) technology utilized by Securicor, the number of simultaneous voice conversations that can be handled in a given amount of spectrum in a given geographic area can be significantly increased by adopting band plans with narrower channel spacings.[1] As noted above, Securicor has advocated an even more spectrum-efficient channelization plan based upon 5 kHz channelization. In doing so, it maintains that it is well within the state-of-the-art to carry individual voice conversations in 5 kHz channels at a quality level that is more than adequate for PLMR applications. Thus, Securicor maintains, and we assume in the balance of this report, that, at least down to 5 kHz, narrower channels translate directly (and linearly) into greater spectrum efficiency.

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[1] Accordingly, a convenient measure of spectrum efficiency is voice channels (VCs) per MHz per square mile, i.e., VC/MHz/Mi^2. See Dale N. Hatfield, "Measures of Spectral Efficiency in Land Mobile Radio," IEEE Trans. on Electromagnetic Compatibility, Vol. EMC-19, No. 3, August 1973, p. 226.

In the analysis which follows, we primarily consider the impacts of going to the more spectrum-efficient technology in the 150-174 MHz and 450-470 MHz bands. However, we also provide an estimate of the economic value of employing the more efficient technology in the 470-512 MHz band, portions of which are available in larger metropolitan areas.

III. Increase in Capacity Associated with a 5 kHz Channelization Plan

Under the assumptions described in Section II, we computed the additional spectrum and the equivalent number of voice channels that would be created by adopting Securicor's more spectrum-efficient plan. We computed the results for the 150-174 MHz and 450-470 MHz bands rechannelized according to a 5 kHz band plan. The results are presented in Table 1, below:

Table 1

Frequency Band (MHz)	Number of Paired Channels Possible in the 150-174 and 450-470 MHz Bands With Different Channel Spacings			Extra Spectrum Created By Going to 5 kHz Spaced Channels	
	7.5 kHz Spaced Channels	6.25 kHz Spaced Channels	5 kHz Spaced Channels	(MHz)	No. of Chan-nels
150-174	553[2]	N/A	830	2.77	277
450-470[3]	N/A	1244	1,555	3.11	311
Totals:	1,797		2,385	5.88	588
Percentage increase in the number of paired channels by utilization of 5 kHz spaced channels in both bands instead of the 7.5 kHz and 6.25 kHz spaced channels specified in the R&O/NPRM= 32.72.					

With reference to Table 1, the numbers of paired channels that could be created by the 5, 6.25 and 7.5 kHz channel spacings were developed by actually counting the relevant frequencies in each of the two bands, including the tertiary channels in the 150-174 MHz band. This means that the channel assignments in this band are spaced 15 kHz apart. The

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[2] The count of 553 channels does not include the four remote control and telemetry channels located at 154.45625, 154.46375, 154.47125, and 154.47875 MHz. For simplicity, the twelve 25 kHz spaced channels in the 172 MHz area are assumed to really be only 15 kHz spaced channels, in keeping with the remainder of the band. The actual total amount of PLMR refarming spectrum in this band is therefore equal to 8.430 MHz; however, for convenient manipulation without loss of significant contributions, we assume the total amount of refarming spectrum is equal to 553 channels x 0.015 MHz/channel or 8.295 MHz.

[3] We could not match the Commission's count of 324 Part 90 services channels in this band. Instead, we counted 311channels considered for refarming. We chose to use our count in order to be more conservative. Hence, the total amount of refarming spectrum in this band amounts to 311 channels x 0.05 MHz/channel or 15.550 MHz.

channels are currently unpaired. To allow for the introduction of modern repeater or trunked repeater systems, we conservatively assumed only paired channels would be placed in the spectrum created by the adoption of the more spectrum-efficient technology. Thus, on a non-paired-channel basis, our count of 553 existing channels in the 150-174 MHz band would result in double this number for a channel spacing of 7.5 kHz. However, since we are considering only paired channels, the 7.5 kHz channel spacing does not increase the present number of channels that are assignable. The use of 5 kHz channelization produces 830 channels for a gain of 277 channels or 2.77 MHz as shown in the table.

Since the channels in the 450-470 MHz band are already paired, computation of the number of achievable 6.25 kHz and 5 kHz spaced paired channels is more straightforward. We simply get 4 and 5 times as many of these channels as there are at present for the 6.25 kHz and 5 kHz spaced channels respectively. Since we counted the present number of channels in this band to be 311 (instead of the R&O/NPRM's 324), one could obtain 1,244 channels spaced 6.25 kHz apart or 1555 channels spaced 5 kHz apart. This represents a net gain of 311 channels or 3.11 MHz. Thus, in total, slightly less than 6 MHz of additional spectrum would be freed up by adopting the more spectrum-efficient technology in the two bands. Although we did not include them in Table 1, additional channels would also be created by adopting Securicor's more spectrum-efficient band plan in the 470-512 MHz range.

It should be noted that, according to Securicor, a mixed LM-FM environment requires very substantially lower co-channel protection ratios than does an all FM environment. This is very important in the transition period to new technologies since it

allows much tighter packing of base stations for any given base station coverage areas, and this, in turn, results in great spectrum efficiency gains. Relative to today's all FM environment, an all LM environment requires a co-channel interference protection ratio of about 2 to 6 dB less than for an all FM environment.[4]

If one assumes a representative fourth power propagation falloff with distance, i.e. a 40 dB/decade falloff rate, one can estimate the reduction in the D/R ratio[5] that, say 2 and 6 dB of improvement in co-channel protection ratio provides. Under these conditions, the distance between co-channel assignments can be reduced to about 89 percent of its FM-FM distance, assuming a fixed base station coverage area radius, for a 2 dB improvement. Equivalently, one can reduce the needed D/R ratio in this same proportion. If pilot tone frequency offsets were carefully controlled, the required LM-LM protection ratio is conservatively 6 dB less than for the FM-FM case, again according to Securicor. In this case, the needed D/R ratio for LM-LM operations could be reduced to about 71 percent of that required for FM-FM systems. These are not trivial figures. In terms of voice channels per MHz per square mile, spectral efficiency is roughly inversely proportional to the square of the D/R ratio.

We can estimate the impact that the 2 and 6 dB less co-channel interference protection ratio for all LM systems has on the required D/R ratio by ignoring any slight protection ratio

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[4] Securicor claims that if the pilot tone frequencies are carefully maintained a few tens of Hz apart that the co-channel LM-to-LM protection ratio can be up to 6 dB better than for today's FM-to-FM protection ratio. If the pilot tones are essentially locked together, the improvement reduces to about 2 dB.

[5] D is the required distance between identical facility co-channel base stations and R is the radius of acceptable service coverage radius about each of these base stations.